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MUNICIPAL CAPITAL MAINTENANCE AND FISCAL DISTRESS

Mary Bumgarner, Jorge Martinez-Vazquez, and David L. Sjoquist*

Abstract—This paper formalizes and empirically tests the hypothesis that the deficient maintenance of public infrastructure is caused by fiscal distress. We utilize a production-decision framework in which public officials combine maintenance and new capital to produce a desired level of capital services. The behavior implied in the fiscal distress hypothesis is treated as perverse deviations from the optimal production path. The empirical findings from cross-sectional expenditures data give support to the fiscal distress hypothesis.

I. Introduction

THE issue of America's deteriorating public infrastructure has recently received increasing attention from the news media, and in coming years is likely to become an important area of research interest in government finance. While a general consensus has emerged from the existing data as to the threat posed by declining maintenance and capital formation, the causes of the phenomena have yet to be identified.

The purpose of this paper is to formalize and empirically test the most commonly raised explanation for the observed phenomena, namely, fiscal distress. This hypothesis, first suggested by Peterson (1980), loosely states that fiscally distressed governments behave myopically, decreasing capital maintenance and replacement in order to finance more visible service activities.[1]

To formalize the fiscal distress hypothesis, we utilize a production-decision framework in which local managers combine maintenance and new capital to produce a desired level of capital services. For a given technology, the desired combination of capital services and other inputs are assumed to depend on the level of public services and input prices. Input combinations are allowed to vary across different service delivery environments. The behavior implied in the fiscal distress hypothesis is treated as perverse deviations from the optimal production expansion path.

The fiscal hypothesis is tested empirically using cróss-sectional expenditure data collected from 42 city budgets from 1978–79. Our findings show that fiscally distressed cities engage in considerably lower capital and capital-maintenance expenditures relative to expenditures on current services inputs, after controlling for differences across cities in public service levels, input prices, and service delivery conditions.

The remainder of the paper is organized as follows: section II discusses the production framework and the fiscal distress hypothesis; section III describes the data; section IV presents the empirical results. The final section offers a brief conclusion.

II. Model and Hypothesis

We assume that the expenditure level is given, perhaps determined by the desired of the voters. However, for our purpose there is no need to be concerned formally with how the level of public expenditure is determined. We assume that city managers have control over the composition of expenditures to the extent that they can choose input combinations.

Ideally, local officials as managers allocate the budget so as to efficiently produce public services. The production technology for public services is assumed to be available to all jurisdictions, and it requires the use of capital services and a composite, c, of noncapital inputs. Capital services, in turn, are assumed to be produced by a combination of a stock of capital goods, K, and maintenance services, m. Given that, by assumption, the manager takes the total expenditure level as given, the manager's role is to allocate the government's cash budget between the primary inputs: noncapital inputs, c, maintenance of the existing capital

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[1] Pagano and Moore (1985) investigated whether fiscal distress affects maintenance expenditures. Using a sample of nine case studies (cities) extending over a period of ten to twenty-one years, the authors compare trends in maintenance expenditures for bridges and streets, water, and sewers, for cities fiscally distressed with cities which are not fiscally distressed. They concluded that the literature appears to overstate the importance of fiscal distress.

stock, m, and gross investment, I_g, for replacement and expansion of the capital stock. The cash budget can be expressed as

$$E^* = p_c c' + p_m m' + p_k I_g'$$

where E^* equals total cash expenditure, the p's represent prices, and the primes represent optimal quantities.

Given the production functions for public services and for capital services, the desired expenditures can be expressed as

$$p_m m' = m(p_m, p_k, p_c, r, v, d, sc, A, E^*) \quad (1)$$

$$p_c c' = c(p_m, p_k, p_c, r, v, d, sc, A, E^*) \quad (2)$$

$$p_k I_g' = I_g(p_m, p_k, p_c, r, v, d, sc, A, E^*) \quad (3)$$

where r is the interest rate, v is the vintage of the capital stock and affects the cost of maintaining the capital stock, d is the depreciation rate, sc is the service delivery conditions, e.g., weather and urban density, which affect the cost of producing public services, and A is intergovernmental aid, which may affect relative input usage.

Equations (1)–(3) express how a local government that behaves optimally would allocate a given level of total expenditures, E^*, to the three alternative inputs.

Most of the right hand side variables will differ across jurisdictions. The prices p_m and p_c are expected to be heavily influenced by the price of labor, w, and thus vary if w varies. We expect w to vary because of differences in labor market conditions, cost of living, and extent of public sector unionization. Because of differences in risks, reflected in bond ratings, the interest rate, r, will vary. The rate of depreciation varies due to different intensities of use, while v varies due to differences in the age of the capital stocks. Clearly, there are differences in sc and E^*. However, the purchase price of capital goods, p_k, and the price of maintenance supplies and the nonlabor components of c are expected to be essentially the same across all jurisdictions.

If local government officials operated efficiently, the three desired expenditure equations would determine the municipality's positions along its production expansion path(s) over the long run. It has been argued by Peterson (1980) and others that if voters continue to expect high levels of public services at a time the city faces fiscal distress, elected officials might attempt to continue providing that output by freeing up resources via decreased expenditures on capital maintenance and/or gross investment. It is further agreed that, although myopic, the strategy can be successful in the short run because the consequences of deferring many types of capital maintenance or capital replacement are not immediately visible. Of course, fiscal distress could also force far-sighted rational managers off the long-run path in the short run because large fixed commitments in the non-maintenance component of the budget may restrict the nature of the adjustment to fiscal distress. Either way, we expect to observe that cities experiencing fiscal distress lie off the long-run expansion path.

However, it has been argued repeatedly that public officials are unlikely to be cost minimizers, even in the absence of fiscal distress (Lindsey (1976)). It is also unlikely that a particular jurisdiction will be in a long-run equilibrium at any moment in time.

Observing a cross section of city budgets is, therefore, unlikely to allow us to identify the actual production expansion paths of those jurisdictions. But in addition to these types of inefficiencies and disequilibria, managers of cities subject to fiscal distress may choose an even more inefficient combination of inputs. Thus, cities subject to fiscal distress, if Peterson's hypothesis is correct, would show "perverse" patterns of input usage both over short-run adjustments and in long-run equilibrium. These departures from "normality" are used here in the formalization of the fiscal distress hypothesis.

Cities subject to fiscal distress should be expected to cut all kinds of expenditures, including maintenance expenditures. The fiscal distress hypothesis, therefore, cannot be stated in terms of absolute levels of input expenditure. Rather, the hypothesis maintains that city managers will make a conscious decision to use a nonoptimal input combination. Even if a cost minimizing budget retrenchment calls for a reduction in maintenance relative to current service inputs, managers of fiscally distressed cities, the hypothesis states, choose an even greater reduction in m and I_g and thus adopt inefficient input ratios.

The most distinctive implication of the fiscal distress hypothesis is that the ratios of maintenance inputs to current service inputs and gross investment to current service inputs should fall in the presence of fiscal distress, after controlling for input prices, the level of public service output, and the service delivery conditions. This implication will be tested by using cross-sectional data to estimate equations (4) to (6):

$$E_m/E_c = f(w, r, d, v, sc, A, E^*, Y_m, FD) + \epsilon_1 \quad (4)$$

$$E_I/E_c = g(w, r, d, v, sc, A, E^*, Y_m, FD) + \epsilon_2 \quad (5)$$

$$E_m/E_I = h(w, r, d, v, sc, A, E^*, Y_m, FD) + \epsilon_3. \quad (6)$$

p_k and the price of supplies do not enter (4)–(6) because they are assumed not to vary across jurisdictions. Since there are no direct measures of p_m or p_c, and since these expenditures are assumed to be largely labor, we use w in place of p_m and p_c. Of course, variation in p_k could be obtained by using time-series observations; the difficulty of obtaining time-series data is described in the next section.

The left hand side variables are the three possible ratios formed by the municipality's expenditures on maintenance inputs, E_m, expenditures on current service inputs, E_c, and capital expenditures on gross investment, E_I. Expenditures on inputs are used because of the practical impossibility of measuring the physical level of inputs. All the variables in parentheses on the right hand side have been defined before with the exception of FD, which is a measure of fiscal distress and Y_m, the median income in the community. Median income is used to control for possible differences in resident's time horizons and preferences across jurisdictions. Since the errors are correlated, (4) to (6) are estimated using seemingly unrelated regression, although since each equation has the same variables the results are identical to OLS.

III. Data

Detailed information about municipal expenditures on capital maintenance, E_m, is not readily available. Consequently, to build this series, it was necessary to conduct a line-by-line examination of individual municipal budgets. The forty-two cities chosen for the study had to meet minimum reporting standards, making possible the separation of capital maintenance expenditures from operating activities. City budgets for the 1978–79 fiscal year were located in the Urban Documents Microfiche Collection. School and public utility budgets were not considered part of a city's typical operating expenditures. The primary motivation for ignoring them was the irregularity with which they were reported in the budgets, and the desire to maintain consistency among the functional responsibilities in the sample. Typical maintenance expenditures included street and road repairs, care of the city's traffic lights, street and sign repairs, and building and vehicle repairs. Maintenance expenditures were found in nearly all departments of government but were concentrated in public works, parks and recreation, and police and fire. Many cities reported a specific monetary figure for maintenance or reported their expenditures in such detail that maintenance could be determined through a careful examination of the budget. For several budgets, where the level of specificity was lower, examination of labor schedules and consideration of the functional responsibilities of each department were used to determine maintenance expenditures. When maintenance services were contracted out, these expenditures were included. Clearly, the data for E_m are not ideal. Unfortunately, a more detailed and comprehensive municipal data base is not available. Prior studies of the municipal capital stock, for example, Humphrey, Peterson, and Wilson (1979), used indirect measures of deterioration such as quality assessments made by local engineers and capital maintenance expenditures. However, these studies are descriptive and limited to one or two cities. Pagano and Moore (1985) limit their analysis to roads and bridges and water and sewer systems.

Times-series analysis of this issue would be desirable. However, such data are not available, and collection of sufficient data through the method just described would be extremely difficult.

All operating expenditures not defined as maintenance were classified as current service input expenditures, E_c. These are mostly expenditures on labor services.

Expenditures on capital, i.e., gross investment, E_I, were obtained from *City Government Finances* because they were only sporadically available in the Urban Documents Collection. To be consistent with the measurement of E_m and E_c, our measure of capital expenditures also excludes those on education and public utilities. We measured E_I using capital expenditures for one year and for a three-year average. Results did not differ between the two.

Turning to the explanatory variables, the price of labor services, w, is proxied by the average weekly wage (*WAGE*) for city government workers. A higher wage rate is expected to increase the demand for capital services, including maintenance; a higher wage should also increase the cost of providing capital services through maintenance vis-à-vis new capital stock. Although municipal labor unions can play a potentially significant role in determining labor costs and possible inefficiencies in utilizing labor services, we were unable to identify adequate data in this area.

The differences across jurisdictions in the opportunity cost of capital, r, is proxied by the Moody's bond rating (*MOODY's*). The overall level of "full faith and credit" debt (*DEBT*) is also included as an explanatory variable to capture the intensity of use of debt financing by the jurisdiction. Although both variables, *MOODY's* and *DEBT*, are intended to measure differences in the cost of capital inputs, they may also reflect fiscal distress or urban decline.

There is no information available on the actual rate of depreciation, d, and vintage, v, of municipal capital stock. In their place, several proxies were developed. To proxy vintage we used capital age (*KAG*), measured by the number of years elapsed since the housing stock in the jurisdiction was one-half its current size. The age of the public capital stock should be positively related to the age of the housing stock, although the principal disadvantage of this proxy is its inability to reflect capital replacement. The depreciation rate is proxied by the rate of capital utilization (*KUT*), measured by the percentage of the labor force in the jurisdiction employed in manufacturing. Although less than an ideal measure, relatively high manufacturing employment is expected to be related to a more intense use of infrastructure and thus greater depreciation.[2] Since the rate of depreciation is expected to vary with the vintage of the capital stocks, we interacted *KAG* and *KUT* to form *INTER*.

To control for differences in service delivery conditions across cities, sc, we used land area of the jurisdiction in square miles (*AREA*). As alternatives to *AREA*, we also employed mean January temperature, population, and population density. Cities with larger land areas and cities with less dense population may require different combinations of inputs vis-à-vis older and more density populated cities. Climate can affect relative input intensity, especially through differences in depreciation.

Because there is no reason to expect that production expansion paths are linear, relative input utilization may vary with the level of public services, which was measured by total general expenditures in the jurisdiction (*EXPEND*), excluding education and public utility expenditures. Because a distressed city may be more likely to receive intergovernmental aid which may cause a substitution between expenditure categories, we included *AID*, the amount of intergovernmental aid.

To measure fiscal distress (*FD*) we used the index of urban decline developed by Bradbury, Downs, and Small (1982). This index measures urban decline in terms of negative changes in the unemployment rate between 1970 and 1975, in the violent crime rate between 1970 and 1975, in the city debt burden between 1971 and 1975, and in the percentage change in per capita income between 1969 and 1974. The dates for the fiscal distress variables and the fiscal years for the expenditure data are not overlapping. We do not believe that this is a problem and may even be desirable, since the effect of fiscal distress is likely to be more pronounced after a short lag. It may be that the lag is too long so that the fiscal distress may have been played out by 1978. However, it does not appear that the situation in our sample of cities changed substantially in the period 1975–1980. Although some of the components of the urban decline index are not directly related to the fiscal health of the city, e.g., the violent crime rate, the case can be made that at least each of the components is correlated with fiscal health. Furthermore, they may work better as instrumental variables for fiscal distress because they are not highly correlated with other explanatory variables.

[2] We are aware of no literature that relates depreciation of the infrastructure in general to the level of manufacturing. However, factors associated with manufacturing have been shown to affect the depreciation of infrastructure, e.g., through pollution (see Kucera, 1978) and truck traffic (see Small, Winston, and Evans, 1989).

TABLE 1.—MEANS AND STANDARD DEVIATIONS

Variable	Definition	Mean	Standard Deviation
E_m/E_c	Maintenance exp./service exp.	0.18	0.07
E_m/E_I	Maintenance exp./capital exp.	0.61	0.40
E_I/E_c	Capital exp./service exp.	0.40	0.26
EXPEND	Total general expenditures[a] (millions of $)	139.00	176.58
KAG	Years since housing stock was 1/2 current size[b]	37.16	14.19
KUT	% labor in manufacturing[b]	20.27	7.88
WAGE	Weekly wage for maintenance workers[a]	231.00	57.19
AREA	Land area in square miles[b]	106.51	113.51
FD	Fiscal distress[c]	0.12	2.26
INTER	*KAG* × *KUT*[b]	789.02	472.99
DEBT	Full faith and credit debt[d]	127.70	135.90
MOODY's	Moody's bond rating	4.35	1.51
AID	Total intergovernmental aid[d] (millions of $)	104.64	140.12

Note Number of cases = 42
[a] Source· City Budgets from Urban Documents Microfiche Collection
[b] Source. U.S. Department of Commerce, Bureau of the Census, *County and City Data Book*, Washington, D C., GPO, 1980.
[c] Source· Bradbury, Downs and Small (1982).
[d] Source *City Government Finances* in 1978 and 1979, Bureau of the Census

As constructed, total urban decline scores ranged between −4 and +4, with severely disadvantaged cities receiving the most negative scores and healthy cities receiving the highest scores. To aid in the interpretation of the regression coefficients, the scores were multiplied by −1, thus *FD* increases with the level of fiscal distress. Table 1 presents the means, standard deviation and sources of all the variables.

IV. Empirical Results

Equations (4) to (6) were estimated as a linear specification using seemingly unrelated regression. All estimations are corrected for heteroscedasticity, which was detected in initial OLS regressions employing a correction suggested by Park (1966). The results of the regression analysis are presented in table 2, where regressions (1)–(3) correspond respectively to dependent variables E_m/E_c, E_I/E_c and E_m/E_I.

The coefficient on the fiscal distress variables, *FD*, is negative as expected, and significant in the E_m/E_c and E_I/E_c equations. For equation (3), with dependent variable E_m/E_I, the coefficient for *FD* is not statistically significant. This latter result is not surprising given that cities in fiscal distress may reduce both maintenance and capital replacement. The coefficients for *FD* in equation (1) and (2) are clearly consistent with the fiscal distress hypotheses. After controlling for input prices, environmental conditions and level of production, we find that cities that are fiscally distressed engage in less capital maintenance and replacement relative to expenditures on current service inputs. Since the range of values of *FD* is limited to +4 to −4, we reconstructed *FD* as a series of dummy variables. The regression equations using the set of dummy variables do not change the implications of the results of table 2 concerning the effect of fiscal distress.[3]

The two variables serving as proxies for capital depreciation and vintage effects, *KAG* and *KUT*, are statistically significant and take the expected sign in equation (1) for E_m/E_c and are marginally significant and of the expected sign in equation (3) for E_m/E_I. Other things the same, the older the capital stock and the higher the intensity of

[3] There exist in the literature several alternatives measures of urban fiscal distress; e.g., Ladd and Yinger (1989) and Fosset and Nathan (1981). Ladd and Yinger, in particular, present measures of fiscal capacity and fiscal health for 21 cities in our sample. However, the Fosset-Nathan and Ladd-Yinger indexes measure the relative level of fiscal health, not the change as does the Bradbury-Downs-Smalls index. Empirically Ladd and Yinger's fiscal capacity measures perform as well as the Brookings index. The Fosset-Nathan index and Ladd-Yinger index of health were not statistically significant.

TABLE 2.—SEEMINGLY UNRELATED REGRESSION EQUATIONS

	E_m/E_c (1)	E_I/E_c (2)	E_m/E_I (3)
Constant	1.797	0.161	0.641
	(0.259)	(0.607)	(1.352)
KAG	0.550	0.160×10^{-2}	0.012
	(3.982)	(0.301)	(1.317)
KUT	0.499	-0.35×10^{-2}	0.019
	(2.510)	(0.461)	(1.451)
INTER	−0.022	0.011×10^{-2}	-0.066×10^{-2}
	(3.469)	(0.464)	(1.497)
AREA	-0.476×10^{-2}	0.131×10^{-2}	-0.136×10^{-2}
	(0.645)	(4.640)	(2.695)
WAGE	0.042	0.047×10^{-2}	0.073
	(2.554)	(0.755)	(0.649)
MOODY's	−0.398	0.017	−0.096
	(0.562)	(0.621)	(1.983)
DEBT	−0.027	-0.032×10^{-2}	-0.071×10^{-2}
	(3.876)	(1.245)	(1.502)
EXPEND	0.022	0.0242×10^{-2}	0.390×10^{-2}
	(1.565)	(4.366)	(3.947)
AID	−0.033	0.212×10^{-2}	-0.417×10^{-2}
	(1.969)	(3.261)	(3.598)
FD	−0.856	−0.030	−0.015
	(2.602)	(2.394)	(0.703)
R^2	0.829	0.752	0.579
$\bar{R}^2$	0.775	0.672	0.443
F-statistic	15.11	9.412	4.26
Sample Size	42	42	42

Note. Absolute t-statistics are in parentheses.

its use, the greater the importance of maintenance inputs vis-à-vis other inputs. Neither of the two variables are significant in equation (2), i.e., for E_I/E_c.

We included the variable *INTER*, the interaction between *KAG* and *KUT*, in all three equations. The coefficient is negative and significant in equations (1) and (3) and F-tests indicate that *INTER* contributes significantly to the explanation of the variation in E_m/E_c and E_m/E_I. The negative and significant coefficient for *INTER* suggests that the older the capital, the smaller the effect on maintenance expenditures resulting from an increase in utilization. This result suggests that older capital does not wear out as fast as new capital and thus requires less maintenance. This interpretation is not intuitively appealing. However, it may be that cities with older capital find it more efficient to replace capital than to maintain it. This explanation is consistent with the negative coefficient on *INTER* in equation (3) and the positive, although insignificant coefficient in equation (2).

The proxy used to control for differences in services delivery condition, *AREA*, takes a positive and significant coefficient in equation (2) for E_I/E_c and a negative and significant coefficient in equation (3) for E_m/E_I. For equation (1) the coefficient for *AREA* is not statistically significant.[4] Other things the same, equations (2) and (3) suggest that cities with larger land area spend more on investment vis-à-vis other inputs. This may be because larger cities, as measured by land area, are newer cities, and newer cities are in more need of physical capital expansion.

The coefficient on *WAGE* is only significant in the E_m/E_c equation and takes a positive sign. At first glance this positive sign may be surprising. However, it is not difficult to design scenarios for this result to occur. A higher wage means higher p_m and p_c. If the production of m is more labor intensive than for c, p_m is more reflective of w than p_c. A higher p_m relative to p_c implies that m should be relatively smaller. However, the dependent variable is the ratio of expenditures. Thus, unless the demand for m is very elastic, a higher wage, and hence a higher p_m, should result in higher value for E_m than E_c. Although the coefficients on *WAGE* in equations (2) and (3) are not significant, their signs are consistent with the argument just made.

The coefficient on *MOODY* is statistically insignificant in all three equations, while the coefficient on *DEBT* is negative and significant in the E_m/E_c equation and marginally significant in the E_m/E_I equation. The strong role played by *DEBT* in equation (1) could be due to the fact that this variable captures some measure of fiscal distress. However, dropping *DEBT* from the equations does not affect the coefficients of the fiscal distress variable.

The coefficient on total expenditures, *EXPEND*, is marginally significant in equation (1), negative and significant in equation (2) and positive and significant in equation (3). Other things the same, the larger the expenditure on public services the smaller the share of total expendi-

[4] Three alternative measures of service delivery conditions were considered, population, population density, and mean January temperature (see Vernez, 1976). Population performed as well as *AREA* while the other two did not; multicollinearity may have been the problem. Mean January temperature, for example, is highly correlated with *KAG*, since older cities are generally located in the colder climates.

tures on new capital vis-à-vis other inputs.[5] The coefficients on intergovernment grants, *AID*, is statistically significant in all three equations. The coefficients suggest that intergovernment aid increases capital expenditures relative to maintenance and other inputs and may decrease maintenance relative to other inputs.

A decline in median income as reflected in *FD*, might be associated with an increase in the number of low-income residents. If, as argued by Banfield (1970), low-income residents have shorter time horizons, then this might be the cause of a decrease in relative maintenance and capital replacement expenditures. This suggests using household median income as an additional control variable in order to empirically distinguish between the fiscal distress hypothesis and this alternative. Adding household median income as an explanatory variable to the regressions causes some changes in the coefficients, in part because of the correlation of median income with other explanatory variables, e.g., *KAG*. However, the introduction of income does not affect the sign or statistical significance of the coefficients for fiscal distress, *FD*. Income itself is positive and is significant in equations (1) and (3), which is consistent with Banfield's argument.[6]

V. Conclusion

The purpose of this paper was to model and empirically test the hypothesis that urban capital deterioration occurs because fiscally distressed cities decrease capital maintenance and capital investment in order to fund other more visible city services.

Although the empirical results should be interpreted with care due to data constraints, the results do indicate that fiscal distress results in a decrease in maintenance and in investment in order to finance other expenditures.

[5] To control for the possible independent scale effects of changes in population, all equations were run with two alternative independent variables: change in population from 1960 to 1970 and a dummy variable equal to one if population had decreased in both the 1950–60 and 1960–70 decades. The coefficients for these variables were never statistically significant. In the presence of the population variables, the size of the coefficients for the fiscal distress variable did not change, although there were slight increases in their t-values.

[6] These results are available from the authors on request.

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